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LESPEDEZA SERICEA AND OTHER PERENNIAL LESPEDEZAS FOR FORAGE AND SOIL CONSERVATION

By

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and
Division of Conservation Operations
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UNITED STATES DEPARTMENT OF AGRICULTURE

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LESPEDEZA SERICEA AND OTHER PERENNIAL LESPEDEZAS FOR FORAGE AND SOIL CONSERVATION[1]

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INTRODUCTION

The farmers of the South first became acquainted with lespedeza[2] through the important service rendered by the two annual species, common and Korean. These two are the only annual forms among the 125 known species of the genus; the others are perennials. The lespedezas are found only in eastern North America and in eastern Asia. About 20 perennial species are native to North America. None of the oriental species is indigenous to America and the American species are not found in the Orient. Of the perennials, some 25 species and varieties have been grown in the nurseries of the Bureau of Plant Industry.

The perennial lespedezas may be considered in two groups—shrubby species and herbaceous perennials. To the former group belong such species as *Lespedeza bicolor, L. cyrtobotrya,* and *L. thunbergii.* These species make a growth of 6 to 10 feet in height. Where the annual growth is not killed by frost, woody stems that may become 1 to 2 inches in diameter develop. New growth comes from the

[1] Contribution from Soil Conservation Service and Bureau of Plant Industry.

[2] As used in this circular the terms "lespedeza" and "lespedezas" mean perennial (not annual) lespedezas and unless otherwise stated will refer to *Lespedeza sericea.* For a discussion of the annual lespedezas see Pieters (*19*).[3]

[3] Italic numbers in parentheses refer to literature cited, p. 42.

woody stems each spring. Where winters are severe enough to kill the current growth, new growth comes from the crown buds. All the native American species and *L. sericea*, *L. juncea*, *L. latissima*, and others, are herbaceous perennials, the annual growth of which dies down to the ground every year.

Of the oriental species, a few shrubby species as *L. bicolor*, *L. japonica*, and *L. thunbergii*, have long been sparingly used as ornamentals, but not until 1924 when the United States Department of Agriculture introduced *L. sericea* were any perennials used in agriculture in the United States.

Lespedeza sericea was first tried in 1896 by McCarthy (*11*) of the North Carolina Agricultural Experiment Station. There is no evidence that he made observations on any but the first year's growth, and on this basis he condemned the plant as being without value. In 1899 Seaman A. Knapp, then in Japan, sent seed of this species to the Office of Foreign Plant Introduction of the United States Department of Agriculture, and some of this seed was planted at Arlington Experiment Farm in 1900. Here it grew for several years, but little attention was paid to it and the plot was later destroyed. Some plants escaped to a remote part of the Arlington farm, where they were found in 1925. The Office of Foreign Plant Introduction also sent seed to a farmer in Tennessee and from this planting the species apparently escaped and became established over a considerable area in Overton County, Tenn. (*12*, *16*).

In 1924 the Bureau of Plant Industry secured seed of a number of legumes from Japan, among them seed of *Lespedeza sericea*. These lots were planted in the legume nursery at Arlington Experiment Farm, Va., and *L. sericea* No. 12087 appeared to be of most promise. Seed of 12087 was distributed for trial in succeeding years as was that descended from the original Knapp introduction, which was given No. 04730. Later a limited quantity of seed of *L. juncea* and *L. latissima* was distributed, but up to the present time only *L. sericea* has made any material advance. The discussion in this circular will, therefore, relate to *L. sericea* unless some other species is named.

During the last few years *L. sericea* has proved of value in erosion control, and many plantings have been made for this purpose. Its value for erosion control, hay, wildlife, and seed production has been demonstrated. No common name has been formally proposed and adopted. Some have called *L. sericea*, Chinese lespedeza, but there is no good reason for this. The seed came to the United States Department of Agriculture from Japan. The name "sericea" is being widely used and seems as good as any. In this circular, therefore, *L. sericea* will be referred to as sericea.

HABIT

Sericea has a habit of growth like that of alfalfa. The current growth matures seed and dies in late fall, and the new growth comes from the crowns the following spring. During the first season one erect stem is produced (fig. 1, *A*). Additional stems come from crown buds the following years so that in the third or fourth year there may be 20 to 30 stems per plant (fig. 1, *B*). An isolated plant has been known to produce 100 stems.

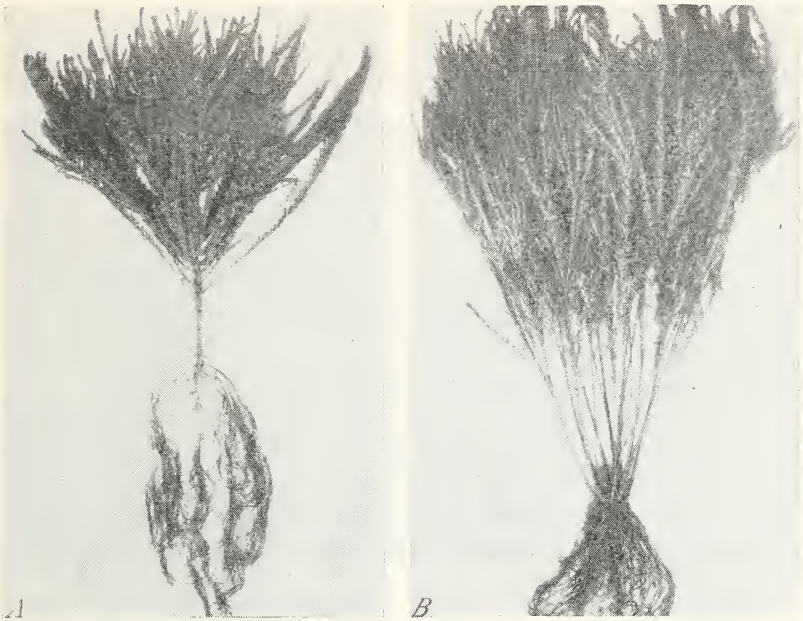

FIGURE 1.—*A*, A plant of sericea in its first year, from a cultivated row. Note the single stem. *B*, A plant of sericea in its second year's growth. Note the many stems from the crown. Courtesy T. W. Wood & Sons.

The height of the first year's growth depends largely on the methods of seeding. In cultivated rows the plants may attain a height of 3 to 4 feet the first season and be well branched (fig. 1, *A*). If the seed is broadcast, the first year's growth may be some 12 to 18 inches in a good season. Plants from a seeding in grain or on weedy land or in a dry season may make only a few inches of growth.

In all cases the second year's growth will attain a height of 2 to 5 feet, depending on moisture and soil conditions, will be dense, and will be well branched unless the stand is very thick. Full growth is usually attained the second season, but if the first season's growth is very short by reason of severe conditions full growth may not be attained until the third season (fig. 2).

The roots are woody and widely branched and penetrate the soil to a depth of more than 3 feet (fig. 3). They have been known to penetrate tight clay soils (*5*). The size of the roots in a mature stand will depend on the thickness of the stand. Isolated plants have larger roots than those that are crowded. This abundant and vigorous root system enables it to hold eroding soils and to resist prolonged dry weather. Sericea has been reported to have survived a 5-day overflow in Arkansas that killed alfalfa, and in Alabama it has survived annual overflows that damaged Johnson grass.

As far as studies have been made, sericea appears to be immune to the root knot nematode, and this fact adds to its value as a soil-improving crop on lands that are later to be planted to crops susceptible to root knot.

FIGURE 2.—A 6-year-old broadcast stand of sericea at the Arlington Experiment Farm, Va.

FIGURE 3.—Root systems of sericea at Columbia, Mo. The roots are 2 years old.

FIGURE 4.—Comparative heights attained in thick and thin stands at Arlington Experiment Farm: *A*, thin stand, 4.5 feet; *B*, thick stand, 2.5 feet.

Plants growing in a thin stand (fig. 4, *A*) commonly grow larger than those in a thick stand (fig. 4, *B*). For hay production a thick stand is most desirable.

CLIMATIC AND SOIL ADAPTATIONS

To delimit precisely the climatic and soil adaptations of this crop is not yet possible. It has survived several seasons in southern Vermont and southern Michigan and has been known to survive winter temperatures of −17° F. On the other hand, it has gone out or has been severely injured in sections with less severe winter conditions. The variation in results may be due to differences in heaving, or in ground cover, snow, or debris. It has been observed that plants in cultivated rows suffered more than those in broadcast stand. Buds that are stimulated by warm days in February may be killed by a subsequent drop in temperature. Sericea is as sensitive to cold while in a growing condition as any species of lespedeza. In the South a stand may start growth early and become several inches high only to be cut down by a late freeze. This does not kill the plants, however, but cuts down the new growth.

FIGURE 5.—Effect at the end of 9 months of the length of growing day on three plants that were originally the same size: *A*, grown under a long day, was 92 inches high and had a few blooms; *B*, grown under normal day, was 40 inches high and had ripe seed; *C*, grown under a short day, had not grown more than 6 inches high.

Sericea is also affected by length of day. It does not seed where the days are too long, as in Oregon. In southern Michigan it has been known to seed sparingly. In an experiment by the Bureau of Plant Industry, begun March 4, 1936, at Washington, D. C., three plants, originally the same size, were grown under different lengths of day. One plant was grown under artificial light until 11 p. m.; a second under a normal day; and a third under a short or 8-hour day. In 1 month the first plant grew to 17 inches, the second to 9 inches, and the third to 6 inches. Figure 5 shows the results after 9 months.

While sericea will endure extreme drought when well established, it is in no sense a dry-land plant. The fact that it makes little growth during the cool, moist spring subjects it to extreme hardships caused by droughts in summer. At Hays, Kans., it has lived for several years but has not made growth enough to compete with sweetclover and alfalfa, which can take full advantage of the spring moisture. As far as present knowledge goes, therefore, sericea would appear to be a plant for the territory from perhaps a hundred miles north of the Ohio River to the Gulf of Mexico and from the Atlantic to central Kansas and Oklahoma.

Sericea thrives best on clay loams and silt loams but has made good growth on sands and sandy loams and has done well on some acid muck soils. It does not thrive on poorly drained soil. It has not done well on the black lands at West Point, Miss., on the Delta lands in Mississippi, or on the low lands at Jeanerette, La. The Tennessee Agricultural Experiment Station (*13*) reports that it failed to thrive on a fertile brown loam in middle Tennessee. No reason can be given at present for the failure of sericea to do well on these fertile soils. Its best growth is apparently made on soils on which it is most needed, namely the poor, eroded clays, silts, or silt loams of the Piedmont and on similar soils elsewhere. On these soils alfalfa and the clovers do not thrive. In east-central Alabama it thrives on a stiff "brick clay" on which cultivated crops fail.

While, in general, sericea will thrive on poor, eroded soils, it should be pointed out here that some soils in the Piedmont have been so badly eroded that not even sericea thrives. The result is doubtless related to the degree of erosion and the character of the subsoil in the exposed horizon. While sericea will do as well on such soils as any other plant, it should be borne in mind that the attempt to grow it under such conditions without the addition of lime or fertilizers or both is certain to result in disappointment. While sericea will grow under irrigation in the West, it does not compete with alfalfa in quantity and quality of hay produced. It is not a competitor of alfalfa. Its place is on the sour, eroded soils of low fertility level throughout the southeastern quarter of the United States.

CULTURE

GERMINATION OF HARD SEED

Sericea seed as harvested is in the hull. While the hull is but a delicate membrane that readily absorbs water, the seed coat is hard and in most of the seeds is impermeable to water. This results in a low percentage of germination.

Many germination tests have been made both in the seed laboratory of the Department and in soil or sand in the greenhouse. The results have varied widely. In some cases the germination of the unhulled seed has been as low as 2.5 percent, with 88 to 91.5 percent remaining hard. In others up to 72 percent of the unhulled seed have germinated with 19.5 percent remaining hard. In most cases, the range of germination of unscarified seed has been between 10 and 20 percent.

Selection work was carried out by the Bureau of Plant Industry over several years with the hope that the descendants of certain individual plants that in 1928 produced a high percentage of quickly germinable unhulled seed might inherit this quality. No progress was made, however, as descendants of plants producing in one year a high percentage of quickly germinable unhulled seed were, in later years, no better than the average. No explanation can be offered today for this variation in results. Possibly climatic conditions when the seed is ripening may have an influence, but no evidence has been found to sustain this supposition. The variation in results from year to year is shown by the record of five individual plants (table 1).

TABLE 1.—*Percentage of germination and of hard seed in unhulled seed from 5 individual plants, Arlington Experiment Farm, Va., 1930–33*

Item	1930		1931		1932		1933	
	Germination	Hard seed	Germination	Hard seed	Germination	Hard seed	Germination	Hard seed
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Plant No. 1	76.0	11.0	3.5	95.5	75.5	18.0	3.0	93.0
Plant No. 2	42.5	50.0	.5	98.5	8.0	90.0	10.5	88.0
Plant No. 3	63.5	17.0	1.5	97.5	20.0	79.5	8.0	90.0
Plant No. 4	56.5	14.0	1.0	97.0	64.5	30.0	8.5	88.0
Plant No. 5	43.0	18.5	2.5	96.0	46.0	53.0	7.0	89.5

Germination was high in 1930, very low in 1931, fairly high in 1932, and low in 1933. A study was made of the effect of the time of harvesting on the hardness of the seed. Branches were cut from five individual plants commencing in mid-October when the seed was well formed but still green and continuing at weekly intervals until mid-November. Germination tests showed no consistent relation between time of cutting and the percentage of hard seed.

Sericea produces some seed larger than others. It is possible that one kind is produced by the flowers with petals and another by the apetalous flowers, but this point has not been studied. A test of the germination of unhulled seed produced by individual plants in the same year showed that the large unhulled seeds germinated more freely than the small ones, the average percentage of germination of seed from the five plants being 62 for the large and 22 for the small. If this should prove to be the rule, a variation in the proportion of large and small seed may explain variations in percentage of germination. This difference in germination may explain why the use of unhulled seed is sometimes attended with success while at other times only a poor stand results.

TREATMENT OF HARD SEED

Hard seed may be treated by various methods all designed to break or soften the impermeable outer coat so that water may enter. Such methods include treatment with sulfuric acid, hot water, dry heat, and mechanical abrasion or scarifying.

All these are effective and their usefulness in practice depends on the economy and convenience of application. The action of winter cold should also be effective, but no data have been secured on this point. In fact, there are some indications that such action is not very effective. Repeated sowing of unhulled seed at Arlington Experiment Farm during winter has never resulted in more than a scattered stand.

Hot water has been shown to be effective. In one series of experiments by the Bureau of Plant Industry boiling unhulled seed for 15 seconds improved the germination from 6.5 percent to 94 percent. In another series of tests it was shown that best results were secured by keeping hulled but unscarified seed for 30 to 45 minutes in water at 70° C. (158° F.) or for 1 minute at 90° C. (194° F.). At higher temperatures for 3 minutes the seed was killed. Dry heat was also effective. Seed kept in an oven at 90° C. for one-half hour germinated 94 percent with 4 percent remaining hard. In a trial with sulfuric acid

it was found that immersion of hand-hulled seed in the acid for 30 to 60 minutes resulted in the germination of 98 to 100 percent of the seed. Immersion for 10 minutes was not so effective, 60 percent of the seed germinating and 35 percent remaining hard.

While these methods have been successful in experimental work, their practical application on a large scale is obviously difficult or impossible. Attention was, therefore, turned to mechanical abrasion and it has been shown that, properly carried out, scarifying is not only effective but also practical. By scarification the germination may be raised to between 75 and 85 percent, depending on the efficiency of the operation. Excessive scarification may result in many seeds being internally injured so that they produce worthless, broken sprouts. Most commercial scarification is done by standard machines made for this purpose.

METHOD OF SEEDING

Sericea is seeded the same way as the clovers, and scarified seed is best seeded alone in late spring. In Missouri and in Tennessee, and occasionally elsewhere, winter seeding of unhulled seed has been successful, but in the Gulf States such seeding has uniformly failed to produce good stands. In Tennessee and at Arlington Experiment Farm in Virginia seeding of scarified seed on winter grain has given good results, but in the Gulf States seeding on grain has not been successful. This failure in the Gulf States is probably associated with spring droughts, during which the competition of the grain was too much for the small sericea seedlings.

The essentials for successful seeding are a firm seedbed and shallow cover. On the soil conservation projects in the Gulf States the most successful method has been seeding scarified seed on a well-prepared bed without a companion crop. The last operation in the preparation of the seedbed should be cultipacking, after which the seed is sown without covering. Rains will wash enough soil from the small cultipacker ridges into the furrows to cover the seed.

If a cultipacker is not available, the seedbed may be well packed and may be dragged with a spike-tooth harrow as the last operation. The seed will fall into the harrow marks and be covered by rains. On sloping land these operations should be on the contour. A spring-tooth harrow is not satisfactory since it loosens the soil too much. Cultipacking after seeding has resulted in good stands, but on some soils it may result in the formation of a crust that would be fatal to the seedlings. Sericea is often seeded on eroded knolls, gullies, and other places where careful soil preparation is not possible. In such cases the surface is lightly scratched with such tools as may be available and the ground mulched after seeding. Almost anything will serve for mulch, the debris from a lespedeza seed crop being especially desirable. When straw is used care should be taken that it is spread evenly and thin. If allowed to fall in bunches the young seedlings are smothered under the thick mat of straw.

Sericea may be started on badly eroded places by covering these with the straw from a seed crop. There will usually be seed enough left in the straw to make a stand. Plants in full seed may be cut and spread on galled spots, but the seedlings are likely to come up so thick as to hurt one another. It is better to knock off half or three-fourths of the seed before spreading the plants.

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RATE OF SEEDING

Seedings of 15 to 20 pounds of scarified seed per acre have given excellent stands, but in the Soil Conservation Service, where many seedings must be made under adverse conditions and where it is important from the standpoint of erosion control to have a thick stand as early as possible, seedings up to 30 or more pounds of scarified seed per acre have been made. Unhulled seed must be used at a heavier rate both because there are fewer seeds per pound and because the percentage of germination will be less. Rates of 40 to 50 pounds of unhulled seed per acre are recommended. Seeding in cultivated rows for seed production requires no more than 2 to 3 pounds of scarified seed per acre.

TIME TO SEED

Good stands have been secured by sowing scarified seed any time from March to July. As a rule too early seeding should be avoided as the seedlings are susceptible to frost. At Arlington Experiment Farm, Va., where sericea can be seeded on winter grain, best results have followed March or early April seeding. Where success with seeding on grain is doubtful, seeding of sericea may well be delayed until after the crabgrass has sprouted and can be killed. In the South, April seedings have given best results, but May and June seedings have also produced excellent stands. Seeding can even be done in early July but it is not well to delay seeding until late July as heaving in winter may be serious. Winter seeding has been successful in some cases. Unhulled seed should be used for winter seeding.

CARE DURING THE FIRST AND SECOND YEAR

A successful stand of sericea requires no attention during the seeding year. Except under very favorable conditions, no crop can be expected the first season. Low-growing weeds as crabgrass are best left alone. They will not hurt the sericea even though they may seem to overgrow it. If, however, the crabgrass is especially vigorous and threatens to mat down, it should be clipped. The mower should be set high enough to miss the sericea. If a seed crop is wanted the first year, planting should be done in rows wide enough apart to cultivate. With proper cultivation, the plants will branch freely, grow 3 to 4 feet high, and produce a good seed crop in the fall of the seeding year.

In the second season growth begins about the end of April in the latitude of Washington, D. C., and in February in southern Georgia and Mississippi. Growth is so rapid that in 1 month the plants may be 18 or more inches high. With a good stand this growth will suppress all summer weeds. Subsequent treatment will depend on the utilization of the crop.

INOCULATION

The organism that produces nodules on the roots of sericea is the same as that active on the annual lespedezas. Wherever these crops or cowpeas are grown or wherever the wild American species of lespedezas are found inoculation will not be necessary. It will probably

be wise to inoculate the seed when seeding on eroded land or on land from which lespedeza has long been absent. While inoculation will eventually take place, a stronger initial growth may be assured by inoculation.

LIME AND FERTILIZERS

Experimental data on the effect of lime and fertilizers on sericea are almost wanting. On land of medium productivity sericea has shown little response to lime and fertilizers. On some soils, however, sericea does respond to soil amendments. Such response is usually more marked during the seeding year than later, and the use of lime and fertilizers may make the difference between a vigorous and a feeble stand.

In the Coastal Plain and in the Sand Mountain area of northeastern Alabama the use of phosphate was found essential to good growth. Here the use of a ton of basic slag or 400 pounds of superphosphate per acre is advised to establish sericea. In Missouri there was apparently no response to lime, but phosphate produced better growth. In Tennessee (*12*) lime was not essential but often gave increased yields. At Tifton, Ga., various fertilizers were tried by the Bureau of Plant Industry, but to none except phosphorus did sericea show any response. Yields were increased 100 percent when phosphorus was given.

A fertilizer trial was carried out by the Bureau of Plant Industry on an established stand of sericea on sandy land at the Agricultural Research Center at Beltsville, Md. Here it was found that the hay yields were increased from 25 to 30 percent by the application of phosphate. There was also some response to potash, but the use of phosphate and potash together gave best results. Chemical analysis showed that the phosphorus content of the herbage was higher where phosphate had been applied than where it was not used.

In the Soil Conservation Service where many seedings are necessarily made on badly eroded land in a low state of productivity, the use of phosphate or of both lime and phosphate is regarded essential to successful stands. On the basis of present knowledge, it may be said that on soils of fair to medium productivity sericea does not need lime or fertilizer. On badly eroded soils or on those poorly supplied with phosphorus applications of lime and phosphate are not only desirable but may often be essential to vigorous growth.

DISEASES

Sericea is not greatly troubled with diseases or insects. Leafhoppers occasionally attack it but do little damage. The Japanese beetle has been reported on ornamental species at Moorestown, Pa., and on sericea at the Arlington farm. It did no damage to sericea. A few plants have been noted that were dying from the attacks of some insect at the base of the stem, but such attacks are infrequent and do no special damage. As will be noted under a discussion of American lespedezas, sericea is free from the rust that is sometimes serious on the American forms and from other serious leaf diseases. A phoma is reported to cause a stem blight (*21*). The cotton root rot attacks sericea the same as other legumes, and this makes sericea useless in the cotton root-rot area.

WEED COMPETITION

While sericea does not suppress weeds during its first season it endures weed competition remarkably well. A first year's growth may be small and apparently smothered by crabgrass, but it will come out strong the next season. If, however, a growth of grass knee high or more falls down, the young sericea may be smothered. Such a growth should be cut before it falls and be removed for hay. A good stand of sericea 2 or more years old will suppress all summer weeds but will not hold down winter weeds that make growth while the sericea is dormant. The effect of the sericea on associated summer growing plants will depend on the way it is handled. If sericea in a good stand is allowed to grow uncut until fall, crabgrass, Bermuda grass, and other summer weeds will be shaded out effectively. When sericea is cut one or more times, the shading effect will be modified. Bermuda grass may live under one cutting, and, if the sericea is cut two or three times, the Bermuda grass may even outgrow and ultimately crowd out the sericea. If the stand of sericea is thin, weeds will invade the field more or less. The remedy is to get and keep a dense, vigorous stand.

The only weed that may be a serious menace to sericea is dodder. This is a parasite and covers mostly the upper parts of the plants. The remedy is to cut for hay even if two or more hay cuttings must be taken. This will practically eliminate the dodder.

SERICEA STANDS

VOLUNTEER STANDS

A thin stand may thicken later by two methods: (1) The existing plants may produce an increasing number of stems in successive years, thus producing a better cover, or (2) seedlings may become established from fallen seed (fig. 6). When the first crop has been allowed to seed, whether this is harvested or not, a certain amount of seed is sure to shatter. Under favorable conditions many of these seeds will produce seedlings and a thickening of the old stand may result.

On good land a volunteer stand is more or less certain, provided competition for light is eliminated. It can be eliminated by cutting the first growth of the older plants for hay. On some areas these older plants have been cut for hay several times in a season in order to give the young seedlings plenty of light. While sericea seedlings endure some shade, the shade from a full growth of established plants, even when in rows 3 feet apart, is so dense that the seedlings are smothered. On medium to good land it is well to allow one crop of the old plants to seed and to cut them once or twice the next season for hay. Full stands have been noted where the original seeding was made on good soil in rows 3 feet apart. The first crop was allowed to seed and 3 years later there was a thick stand.

As it is doubtful whether a volunteer stand can be expected on soils of low productivity, every effort should be made to get a satisfactory stand from the first seeding. Fields have been noted on very poor soil where, even though the old plants had seeded abundantly and had not been cut, practically no reproduction had taken place. It is inferred that in such cases the seedlings that did start could not endure the competition of the older plants. Such competition appears to be chiefly for moisture.

FIGURE 6.—A volunteer stand of young plants coming between older plants of sericea.

NUMBER OF PLANTS FOR A STAND

The number of plants per unit area may be readily determined during the seeding year, but it is difficult or impossible to do this in a well-established stand. The only way to make an exact determination of the number of plants in an old stand is by digging. This was done by the Bureau of Plant Industry in an experiment designed to study the effect of cutting on sericea. Plants were dug in 1936 from a number of square-foot areas in 3- and 4-year-old stands on clay soil at Arlington Experiment Farm and on sandy soil at Beltsville. On the clay soil the number of roots varied from 21 to 32.6 per square foot, or 914,760 and 1,420,056 per acre, respectively. On the sandy soil the numbers were 15.5 and 21.7 per square foot, or 675,180 and 945,252 per acre. In both cases the stands were good. The roots varied in size since some were obviously from 1-year-old volunteer plants while most of them were from well-established plants. The dry weight of the roots ranged from 2,305 to 2,907 pounds per acre on the sandy soil and from 3,692 to 5,168 pounds on the clay soil.

In some areas the number of stems per square foot was determined in the field and was found to range from 68 to 98, with the exception of 188 in one very dense stand. The number of crowns could not be determined, but it was clear that there were 2 or more stems to every crown, making the probable number of plants 25 to 35. In one area what appeared to be a good stand in full growth was found to have 10 to 15 crowns per square foot.

It seems reasonable to conclude that whenever an average of 20 to 30 plants per square foot are present at the end of the first season a good stand may be expected. In some cases a stand of no more

than 10 to 15 plants per square foot may develop into a satisfactory stand. If this conclusion is correct many stands that do not look very good at the end of the first season should not be destroyed as they may develop into satisfactory stands later.

Table 2 shows the results of a rate of seeding trial at Arlington Experiment Farm in 1932. The seedings were made in April and the number of plants per square foot was checked in September. Some of the hulled seed appears to have been scarified also in hulling.

TABLE 2.—*Plants per square foot from seedings at designated rates, Arlington Experiment Farm, Va., 1932*

Seeding rate (pounds per acre)	Plants per square foot from—			Seeding rate (pounds per acre)	Plants per square foot from—		
	Unhulled seed	Hulled seed	Scarified seed		Unhulled seed	Hulled seed	Scarified seed
	Number	*Number*	*Number*		*Number*	*Number*	*Number*
5	----	14	9	15	10	37	32
10	6	32	26	30	12	33	40

SERICEA FOR HAY

Good hay can be made from sericea, but it must be cut early. When cut early sericea hay is leafy, has a good light-green color, and is eaten with relish and little waste. Up to the time the stems are about a foot high very little wood has developed. At this time the cell walls in the lower part of the stem begin to lignify and this condition spreads upward so that when the plant is 2 feet high most of the stem contains a great deal of woody tissue. This naturally increases the weight of material but decreases the quality.

Spring growth is rapid, and if cut early hay of excellent quality can be made. The time that this growth reaches a desirable height for cutting will, of course, vary with the latitude, but the first growth should be cut when from 10 to 15 inches high (fig. 7). Possibly the limits at which cutting should be done may be said to be 10 inches for the best hay and 15 inches for fair to good hay. There is some waste in feeding older hay, especially when fed to cattle. Mules and horses will eat coarser material and have even been known to eat the straw left after a crop of seed was threshed. Much of the complaint voiced about sericea hay is due to the fact that cutting had been delayed until the growth was 24 to 30 inches high. When cut at the proper time, there is very little wood and the material cures with no greater loss of leaves than is experienced with annual lespedeza hay. One of the most successful growers of sericea prefers to cut when the shoots are 8 to 10 inches high. His hay brings locally a higher price than annual lespedeza hay.

Sericea cures quickly and the cut material should be left in the swath as short a time as possible. If left in the swath in the sun too long, the leaves become brittle and shatter. The best method is to leave the cut material in the swath about 45 minutes, then rake it into windrows and leave until the next day. If the weather is favorable, the windrowed hay can be hauled in the day after it is cut. Some

FIGURE 7.—Cutting a crop of sericea hay. This is already too tall to make the best hay.

FIGURE 8.—Cutting sericea hay with a windrowing attachment. This attachment may also be used in harvesting the seed crop.

prefer to place it in small shocks after windrowing and leave until cured. Sericea may also be cut and windrowed in one operation (fig. 8). The weather must, of course, be considered, as too much moisture, especially in the baled hay, may result in heating and in the development of mold. It has been shown that the sooner the hay can safely be put under cover the better it will be.

After the hay is cut, the new growth (fig. 9) comes from the stubs as in sweetclover, not from the crowns as in alfalfa. Sericea should, therefore, not be cut too low. A stubble 2 to 3 inches high is desirable. This second growth may be cut for hay or may be left to produce seed.

FIGURE 9.—Second growth of sericea. The new growth has come from the stubble.

FIGURE 10.—Cutting sericea at the wrong time may kill it. Weeds are growing where sericea was cut for hay the preceding September 15. The strips where sericea is growing were not cut.

NUMBER OF CUTTINGS

All perennial legumes can be cut so often that the plant will be damaged. This is true of alfalfa and kudzu, as well as of sericea. The early growth of these plants is made at the expense of reserve food stored in the roots. This food reserve must be replenished if the plants are to remain alive. The frequency of cutting for any plant will obviously depend on how favorable conditions are for growth. Alfalfa, for example, may be cut six to eight times a year in southern California, but four cuttings a year in Wisconsin result in serious damage.

Sericea also responds to favorable conditions. On good soil in favorable sections three cuttings of hay a year have done no great harm whereas four cuttings seriously reduced the stand. On soil of low productivity, two cuttings may be more than the plants can safely endure. At the West Tennessee Agricultural Experiment Station one hay and one seed crop in a year did not affect the stand and vigor; two hay crops injured the stand about 25 percent, three hay crops 50 percent, and four hay crops 75 percent. Farmers having a good stand of sericea on poor sandy land have been known to cut three or four hay crops a year and then be surprised that the stand disappeared. No other result should have been expected.

The date of the last cutting may also be of some importance, since reserve food is stored mainly by the growth present at the end of the season. In a trial at Arlington Experiment Farm it was shown that cutting about the middle of September damaged the stand severely (fig. 10). The taking of a seed crop has no effect on the stand as by the time seed is ripe the reserve food has already traveled down to the roots.

It seems probable that on poor soil on which the growth of sericea is not vigorous one hay crop only should be taken. The later growth may be taken for seed. On better soil two hay crops may be taken and there may be a small seed crop on the later growth. In rare cases

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only will it be wise to take three hay crops in a year. In this case no seed will be produced. It is believed to be inadvisable to take a hay crop later than the middle of August and preferably not later than early August.

CHEMICAL ANALYSIS

The quality of sericea hay, as determined by its chemical analysis, will depend primarily on the stage of growth when it is cut. As stated earlier, woody tissue begins to form at the base of the stem when the young shoots are about a foot long and extends upward rapidly. When sericea is 3 feet high the main stem and most of the branches are quite woody. This increases the indigestible fiber content.

Analyses of sericea cut at weekly intervals from May 29 to July 31 are shown in table 3. It will be noted that the protein content was highest in the material cut May 29, at a height of about 15 inches, and lowest in the most mature lot, cut July 31. In general, the percentage of crude fiber increased and that of ash decreased with age. There were only minor changes in the percentages of ether extract and of nitrogen-free extract.

TABLE 3.—*Chemical analyses (moisture-free basis) of Lespedeza sericea, strain 04730, leaves, stems, and whole plant, cut from a 4-year-old stand at various stages of growth, Arlington Experiment Farm, Va., 1935* [1]

Date of cutting	Proportion of plant in—		Crude protein			Crude fiber		
	Leaves	Stems	Leaves	Stems	Whole plant	Leaves	Stems	Whole plant
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
May 29	61.6	38.4	20.5	15.4	18.5	27.8	40.6	32.7
June 5	65.5	34.5	18.4	10.7	15.7	26.2	49.6	34.3
12	50.9	49.1	19.3	10.9	15.2	24.2	52.3	38.0
20	55.8	44.2	19.1	9.4	14.8	22.8	52.7	36.0
26	49.6	50.4	17.8	8.5	13.1	22.8	54.7	38.9
July 3	48.2	51.8	17.5	8.2	12.7	22.4	54.7	39.1
10	43.8	56.2	16.8	7.6	11.6	21.9	54.3	40.1
17	44.6	55.4	15.8	6.5	10.6	21.6	54.5	39.8
24	44.5	55.5	15.8	7.3	11.1	22.2	55.7	40.8
31	42.8	57.2	14.5	7.2	10.3	21.1	53.6	39.7

Date of cutting	Ether extract			Nitrogen-free extract			Ash		
	Leaves	Stems	Whole plant	Leaves	Stems	Whole plant	Leaves	Stems	Whole plant
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
May 29	2.31	1.70	2.08	42.8	36.1	40.2	6.54	6.22	6.42
June 5	2.73	1.44	2.28	46.4	33.7	42.0	6.22	4.56	5.65
12	2.75	1.60	2.19	47.8	31.4	39.7	5.90	3.83	4.88
20	2.99	1.03	2.12	49.7	33.6	42.6	5.45	3.29	4.50
26	2.96	1.09	2.02	51.1	32.6	41.8	5.36	3.08	4.21
July 3	3.31	1.15	2.19	51.5	33.0	41.9	5.31	2.96	4.09
10	4.09	1.38	2.57	52.2	33.9	41.9	4.96	2.80	3.75
17	4.39	1.41	2.74	53.3	34.9	43.1	4.89	2.64	3.64
24	4.58	1.27	2.74	52.6	32.9	41.7	4.78	2.60	3.57
31	5.22	1.52	3.10	54.2	35.2	43.3	4.94	2.53	3.56

[1] Analyses by Division of Hay, Feed, and Seed, Bureau Agricultural Economics. Separate analyses were made of leaves and stems. The figures for whole hay above were calculated from those analyses and the percentage of leaves and stems.

Morrison (*14*) gives the average protein content of perennial lespedeza as 14.9 percent and the average digestible protein as 10.7 percent. Unfortunately, feeding trials with sericea are so few that figures on the digestibility of the various constituents must be considered as tentative. It is probable that the digestibility of the protein in the more mature cuts is less than that in the younger and this would tend to increase the spread in value between hay cut when the plants are in the first flush of growth and that cut at a later date. This will also be the case for the fiber. When cut at about a foot high, the hay of sericea contains little lignin; when cut later most of the cells in the stems are woody and this lowers the digestibility of the fiber.

The leaves contain most of the protein. In the series of analyses from which table 3 was calculated the protein in the leaves varied for different cuttings from 20.5 on May 29 to 14.5 on July 31, with an average of 17.55 percent. The protein in stems varied from 15.4 on May 29 to 7.17 on July 31, with an average of 9.17 percent. The fact that the leaves even in the youngest material contain most of the valuable nutrients makes it important to handle the hay so that the leaves will be saved.

A comparison of the figures given by Morrison (*14*) for the percentage of digestible protein from all analyses of various hays shows that hay from sericea ranks well. For comparison, the digestible protein and total digestible nutrients for certain hays as given by Morrison are shown in table 4.

TABLE 4.—*Content of digestible protein, total digestible nutrients, and minerals in certain common hays* [1]

Type of hay	Digestible protein	Total digestible nutrients	Calcium	Phosphorus	Potassium
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Lespedeza, annual, all analyses	9.2	52.2	0.99	0.19	0.84
Lespedeza, perennial [sericea]	10.7	51.9	1.01	.24	.91
Alfalfa, all analyses	10.6	50.3	1.43	.21	2.02
Soybean, all analyses	11.1	50.6	.96	.25	.82
Red clover, all analyses	7.0	51.9	1.21	.18	1.58
Cowpea hay, all analyses	12.6	49.4	1.13	.25	1.45
Bermuda grass	3.7	43.0	.48	.20	1.42
Johnson grass	2.9	50.3	.87	.26	1.22
Orchard grass, early cut	4.6	49.6		.17	1.61
Timothy, all analyses	2.9	46.9	.27	.16	1.36

[1] From Morrison (*14*).

Such average analyses as given in table 4 have but a limited value since the figures include analyses of many lots of inferior hay and therefore do not represent the composition of good hay. They do show, however, that sericea hay ranks well with the legume hays and is very much better than grass hay.

When it is borne in mind that sericea will grow on land too poor and too badly eroded to produce any but inferior crops of poor grass hay, its value in the economy of southern agriculture may be appreciated.

VITAMIN CONTENT

Little is known of the vitamin content of sericea. The vitamin A content was determined in terms of carotene by J. S. Hughes, of Manhattan, Kans., on material submitted by the Spartan Mill & Grain Co., Spartanburg, S. C. The data are given in table 5.[4]

TABLE 5.—*Vitamin A in terms of carotene in three lots of Lespedeza sericea grown near Spartanburg, S. C.*

Cutting	Amount of carotene in 100 gm. of—	
	Leaves	Stems
	Milligrams	*Milligrams*
Second, 10 inches high, sun cured	11.916	2.1
First, 18 inches high, sun cured	9.19	1.179
Second, 12 inches high, dehydrated	27.001	3.679

Hughes adds:

Since the weather has been very warm I imagine these samples have lost as much as 8 to 10 percent of the carotene present at the time you prepared them. It is rather interesting that your sun-cured samples run so high in carotene. Sun-cured alfalfa from Colorado and certain sections of California runs about this high in carotene, while the sun-cured alfalfa in this section of the country runs only about half.[5]

The Tennessee Agricultural Experiment Station (*13*) found that sericea leaves ranked high in vitamins A and G.

MINERALS IN SERICEA HAY

From the limited number of analyses available (table 4), it would appear that sericea hay has about the same phosphorus content as other legume hays but that the calcium content is lower than that of alfalfa, clover, or cowpea hay. It is, however, considerably higher than in grass hay. As a result of a fertilizer trial with sericea on sandy land at the Agricultural Research Center, the Bureau of Plant Industry found that the phosphorus content was increased by the application of phosphate fertilizer. Since sericea is grown mostly on soils low in calcium the small amount of this element in the hay is readily understood.

YIELDS AND LEAFINESS

Yield data have but limited value since the figures show only the results secured on a particular piece of land and with a certain stand cut at a definite time. Yields have been reported by the Illinois Agricultural Experiment Station (*15*) where from 1 ton to more than 3.5 tons per acre were harvested. In Tennessee (*12*) the recorded yields at Knoxville averaged 3.56 tons per acre over a 3-year period. Unfortunately nothing is said in either the Illinois or the Tennesse

[4] Permission to use these data was given by C. B. Fretwell, of the Spartan Mill & Grain Co.
[5] Quoted by C. B. Fretwell in letter to the author Nov. 9, 1936.

record of the growth stage at which the hay was cut. That this can make a great difference is shown by data obtained at the Arlington Experiment Farm in 1929 on hay taken from a uniform stand. Each plot was cut only once. The plot cut June 4 yielded 3,200 pounds per acre; June 17, 3,647; July 1, 5,211; and July 15, 7,223 pounds per acre. In another trial on another field in 1932 the cutting of June 4 yielded 2,032 pounds per acre; June 11, 2,674; June 20, 2,993; and June 25, 4,163 pounds per acre. Naturally the early cutting produced the best hay but the lowest yields. Since the second cutting from the area cut June 4 was much larger than from the other areas, the total yield from the area first cut June 4 was greater than from that first cut June 11 and nearly as great as that from the area first cut June 20. The earliest cutting also produced more protein per acre than either the June 11 or June 20 cuttings. A good stand on medium land may be expected to yield from ¾ to 1½ tons of good hay in each of two cuttings, or a crop of 1 to 1½ tons of hay and a crop of seed.

The leafiness of sericea may be gathered from table 3, where it is shown that in material cut at various dates the percentage of leaves varied from 43 to 66 percent, the earlier cut hay being the more leafy. Since only 45 percent leafiness is required for No. 1 alfalfa hay, it appears that a good grade of sericea hay should be more leafy than alfalfa (fig. 11).

FIGURE 11.—Sericea (*A*) is more leafy than alfalfa (*B*).

FEEDING TRIALS

Few feeding trials have been made, and some of these are unsatisfactory either because there is no information on the quality of the hay fed or because it is known that poor sericea hay was compared with good alfalfa hay. The results of such trials as have been made show a trend and afford some guide to the probable feeding value of sericea rather than definitely indicate the value of good sericea hay.

In Missouri it was found that rather poor sericea hay produced 43 pounds less milk per cow per day than the very best alfalfa.[6] At the Tennessee station (*12*) Holstein cows produced about the same amount of milk on sericea as on alfalfa. The gain in weight of Jersey heifers was also the same on sericea as on alfalfa. Horses maintained their weight for several winter months on sericea alone, without grain.

The Virginia station (*7*) compared Korean lespedeza and sericea hay with alfalfa. All hays were of good to medium quality. The digestibility of the good hay was higher than that of the medium hay and this difference was more pronounced in the lespedezas than in alfalfa. For milk production both lespedezas were of about equal value and were 80 percent as efficient as alfalfa.

In Georgia, Edwards (*3*) fed ground sericea and ground cowpea hay to lambs and found the sericea 81 percent as efficient as cowpea hay for making gains. No bad effects on health were observed.

At Beltsville, Md., on the animal husbandry farm a feeding trial with beef steers was conducted in the winter of 1934–35.[7] The trial lasted 84 days. A rather poor grade of sericea hay produced in 1933 at Arlington, Va., was available and was fed in comparison to good alfalfa hay. The difference in quality is revealed to some extent at least by the percentage of protein, which for the sericea was 10.24, 10.68, and 11.96 for the three feeding periods and for the alfalfa, 15.69, 16.46, and 13.77 for the corresponding periods. Since the sericea hay had been cut when too mature, it is probable that owing to the high percentage of crude fiber the digestibility of the protein in the sericea was also low.

The plan was to feed merely a maintenance ration, but the amount fed, 12 pounds per day, proved to be insufficient. At the end of the feeding period the steers fed alfalfa hay had lost 26.3 pounds per head and those fed sericea hay had lost 54.3 pounds per head. One steer in the sericea lot was obviously in poor condition. If the record of this steer is eliminated the average loss for the other steers was 41.8 pounds per head. During this trial the weather was very inclement because of snow and sleet, but the cattle had shelter under a shed having a southern exposure. The weather together with the poor quality of sericea hay will in part explain the losses in weight.

Wylie and Hinton (*22*) have reported on feeding trials with sericea in four combinations. Three dairy cows were fed all the hay they would consume, as well as fixed amounts of silage and concentrates. Each of the four trials was carried through a 20-day period. The results are shown in table 6. The cows did not eat sericea as readily

[6] C. A. Helm. Letter to the author, August 26, 1936.
[7] Work done cooperatively by the Bureaus of Plant Industry and Animal Industry.

as alfalfa, but they seem to have done well on it. No information is given on the quality of the hay fed.

TABLE 6.—*Hay consumed by 3 cows during each of four 20-day feeding periods and the milk and butterfat produced and gain in weight made* [1] [2]

Feeding period	Hay consumed		Milk produced	Butterfat produced	Gain in weight
	Kind	Amount			
		Pounds	*Pounds*	*Pounds*	*Pounds*
First	Sericea	268.3	2,204.4	81.72	63
Second	do	88.5	1,946.4	78.32	39
	Alfalfa [3]	249.9			
Third	Equal parts of sericea and alfalfa, ground	681.0	1,774.1	72.77	86
Fourth	Sericea and molasses [4]	360.4	1,392.3	62.30	77

[1] Records of Tennessee Agricultural Experiment Station (*22*).
[2] 30 pounds of silage and 10 pounds of concentrates per cow per day were also fed.
[3] Sericea and alfalfa fed on alternate days.
[4] 10 pounds of ground sericea to 1 pound of molasses.

In every case for which data are available where sericea hay has been compared with alfalfa the sericea was cut at a later stage than it should have been cut. Even where it is called good, the analysis shows that the growth must have been 18 or more inches high. As will be shown later (p. 24), it is now known that hay cut at a height of 15 or more inches contains more tannin than that cut earlier. This alone may explain some of the unsatisfactory results from feeding sericea to high-producing dairy cows. Feeding trials with hay cut at 10 to 12 inches in height are greatly needed. Until there is a record of a number of these and until good sericea hay has been compared with grass hay as well as with alfalfa, the real value of sericea for feeding will not be known.

A number of farmers have reported their experiences and while these do not cover comparative experiments, they do express the view that the results with mules, horses, and cattle have been good. There are reports from every State from Virginia to Oklahoma on feeding sericea exclusively for from 1 to 3 years with good results. A county agent in southwestern Virginia reported that mules were carried over winter on sericea hay alone and were in better condition than the year before when they had grain and clover and timothy hay. Farmers in various parts of Tennessee have reported that horses and mules thrive on sericea hay and that in many cases feeding corn has been discontinued as unnecessary. Hogs were said not to relish the hay and some cattle did not like sericea hay at first but did well after getting used to it.

It seems proper to conclude that when sericea is cut at the right stage and well cured it will make a hay little, if any, less efficient in feeding value than alfalfa. If allowed to become too old the value of sericea hay may fall to about 80 percent of that of alfalfa, but even then it is not a bad maintenance ration on which to carry cattle and horses through the winter. It should not be forgotten that a comparison of sericea grown on poor land and alfalfa grown on fertile land is scarcely fair. Sericea hay should be compared with that of annual lespedeza or with Bermuda grass hay grown on land of low fertility.

TANNIN IN SERICEA HAY [5]

All species of lespedeza so far studied contain some tannin. Almost nothing is known of the quality of this tannin, and different methods of analysis give varying results as to the quantity. About 3 to 4 percent of tannin has been found in the annual lespedezas. Oak leaves, which frequently serve as browse in the west, contain tannin.

A number of analyses have been made of sericea hay produced at Arlington Experiment Farm and elsewhere. The percentages of tannin varied, but the general fact has emerged that in the fresh new growth the tannin content is relatively low and that it increases with age.

It is evident that most of the tannin is in the leaves and that the quantity increases rapidly. Between May 29 and June 26 the tannin content of the leaves doubled while there was no change in the amount in the stems. A comparison of the data in table 3 and in table 7 brings out the fact that as the sericea becomes older the protein content declines and the tannin content increases, though not always progressively. This fact emphasizes the importance of early cutting. When cut at a height of not over 15 inches, the protein content will be high and the tannin content low. It is probable that when sericea is cut at a height of 10 to 12 inches, the composition will be even more favorable.

Table 7 shows the tannin content at different stages of growth. The tannin in the whole hay was calculated from the proportion of leaves and stems. The material studied was about 15 inches high when the first cutting was made on May 29. It is now known that the first cutting should have been made when the growth was only 12 inches high.

TABLE 7.—*Proportion of leaves and stems in designated cuttings of Lespedeza sericea, moisture-free plant, and tannin content in the leaves, stems, and whole hay, Arlington Experiment Farm, Va., 1935* [1]

[American Leather Chemists' Association method]

Date of cutting	Proportion of plant in—		Tannin in—			Date of cutting	Proportion of plant in—		Tannin in—		
	Leaves	Stems	Leaves	Stems	Whole hay		Leaves	Stems	Leaves	Stems	Whole hay
	Per-cent	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*		*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*	*Per-cent*
May 29	61.6	38.4	7.5	1.2	5.1	July 3	48.2	51.8	15.5	1.0	8.0
June 5	65.5	34.5	11.0	1.4	7.7	10	43.8	56.2	16.6	1.0	7.8
12	50.9	49.1	12.3	1.1	6.8	17	44.6	55.4	17.7	1.3	8.6
20	55.8	44.2	14.8	1.6	9.0	24	44.5	55.5	17.8	1.3	8.6
26	49.6	50.4	15.4	1.0	8.1	31	42.8	57.2	18.0	1.2	8.0

[1] From CLARK, I. D., FREY, R. W., and HYLAND, H. L. SEASONAL VARIATION IN TANNIN CONTENT OF LESPEDEZA SERICEA. Jour. Agr. Research 58: 131–139, illus. 1939. The tannin content of whole hay was calculated from the figures for the leaf and stem portions.

Analyses of other samples of sericea hay have shown varying percentages of tannin depending to some extent on the proportion of

[5] From cooperative studies on the tannin content of lespedezas by the Industrial Farm Products Research Division, Bureau of Chemistry and Soils, and the Division of Forage Crops and Diseases, Bureau of Plant Industry.

leaves. Hay from which many leaves have been lost will be low in tannin but also in protein.

There is some reason to believe that climate and soil have an influence on the amount of tannin in lespedeza. This is under study but insufficient data have been accumulated to permit final conclusions.

Apparently there is no reason to fear bad effects unless hay cut at too advanced a growth stage is fed in large quantities to high-producing dairy cattle. For these it may be wise to use grass hay as part of the ration or to alternate sericea hay and alfalfa or grass hay so as to reduce the total intake of tannin. Winter grain has been successfully drilled into a field of sericea in late fall, and the resulting growth cut for hay when the grain was in the dough stage. Where grain will make a good growth under such conditions a crop of mixed grain-lespedeza hay of excellent quality can be harvested. Feeding such mixed hay will result in reducing the quantity of tannin consumed.

No definite information has yet been secured on the question of the possible effect of tannin on the health of animals. It has been thought that an excessive intake of tannin may cause disturbances, but nothing is known as to what an excessive intake may be. While theoretically such disturbances may be possible, enough hay has been fed by farmers to show that they do not usually result. The steers fed at Beltsville, Md., did not suffer nor apparently did the steers fed at the Tennessee Experiment Station. The cows grazing sericea at Beltsville and at Green Ridge, Mo., remained in good condition. Reports from farmers who have fed sericea hay almost exclusively for 2 to 3 years emphasize the fact that the stock, especially horses and mules, remained in excellent condition. If the livestock industry is to be encouraged in the South there should be a source of cheap hay. Sericea will supply this on land too badly worn to be used profitably for cultivated crops.

SERICEA MEAL

Sericea has been ground into meal and fed to dairy cows and calves and is said to have given good results. One dairyman reports that calves are less troubed with diarrhea when fed sericea meal. One manufacturer of feeds is using it to some extent to replace material of lower value in low-priced feeds. The protein content of the sericea meal is higher than that of the material for which it is substituted. Sericea meal is said not to have been satisfactory for very young chicks but to be useful for older ones and in one case the dry leaves are said to have been eaten by laying fowls as readily as alfalfa leaves (*13*).

SERICEA FOR SILAGE

Sericea can be ensiled, and when ensiled with molasses the tannin content of the silage is less than in hay made from plants cut at the same stage of maturity. Only preliminary work has been done by the Bureau of Plant Industry and by the Tennessee Agricultural Experiment Station, but the results have been encouraging enough to warrant the following statement by Mooers (*12*):

> Highly palatable sericea silage can be made by the so-called molasses method, as devised for alfalfa and other legumes. A sample of silage made in this way

was found to be nearly tannin-free, which explains its superior palatability. Sericea silage has much higher protein and mineral contents than corn silage and would, therefore, appear to be more nutritious.

Since the cost of raising sericea is very low, and nearly as much dry matter is produced per acre as by a corn crop on the same land, sericea silage may prove of great value to the livestock industry.

A final conclusion on the value of sericea silage must await adequate feeding trials.

SERICEA FOR GRAZING

Perhaps the most controversial subject in the entire problem of the utilization of sericea is its use in grazing. Some, both farmers and experiment-station workers, have declared that cattle will not graze sericea. On the other hand, there are accumulating records of successful grazing extending to nearly every State from the Atlantic coast to Oklahoma. The fact is that sericea has been grazed with good results but that some cattle refuse it. Cattle also refused sweetclover when it first became common in the Corn Belt. It is probably true that sericea is not so palatable to some kinds of livestock as young grass, clover, or annual lespedeza, but cattle can learn to like it, and when they do good results follow. Sericea has high carrying capacity and makes its growth during the summer when bluegrass, redtop, and orchard grass are in poor condition.

At the Beltsville, Md., animal-husbandry farm a 6-acre field containing 1 acre of mixed-grass pasture, 2 of sericea and annual lespedeza, and 3 of sericea only has been grazed for several years. Seven Shorthorn heifers were turned on in the spring (May 8, 1935) and kept there without supplementary feed until October 23. The total gain was 560 pounds for the seven head. A similar lot of cattle on permanent grass pasture, the same season, gained 198 pounds. The cattle did not graze the sericea until about July 15, when it was about 2 feet high. They grazed it down to a few inches and kept it there until they were taken off on October 23. In 1934, Hereford steers were used. They also fed on the sericea when it was 24 inches high and grazed it down to 10 inches by August 10, when they were removed. A heavy new growth was made, and on September 26, cows were turned into this pasture. They ate the sericea readily and cut it down to 8 inches by November 6 (fig. 12).[9]

The Missouri Experiment Station (*5*) records an experience with grazing at Green Ridge, Mo. The cattle were turned from good sweetclover pasture to the sericea field June 15 and for the first few days showed a distaste for the crop. Later they grazed it freely. The milk flow while the stock were on sericea remained constant and equal to that from sweetclover. At the Mississippi branch station at McNeil sericea has been grazed for several years; in fact, grazed so hard that the stand has been weakened.

In Ohio, sericea in a permanent pasture was grazed apparently as well as the other plants. A farmer in southeastern Virginia has grazed a hillside field of sericea for 3 years, turning the cows on it in

[9] Work done cooperatively by the Bureaus of Plant Industry and Animal Industry.

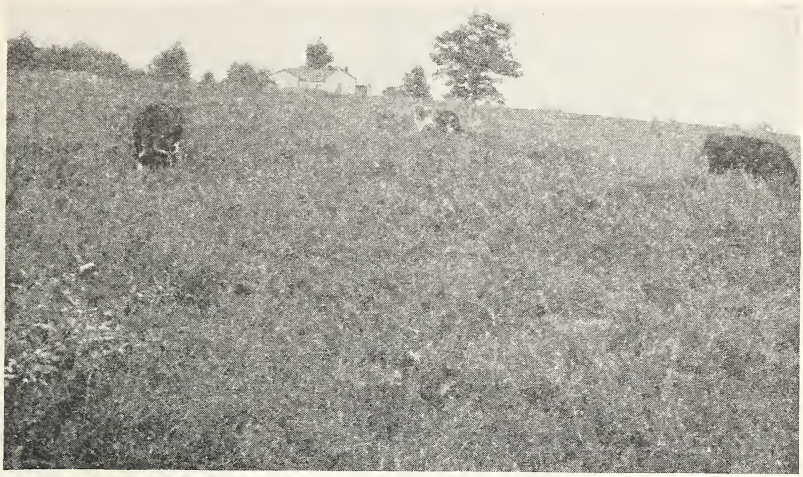

FIGURE 12.—Cows grazing on sericea at Beltsville, Md., in October. Note that the sericea has been grazed down.

FIGURE 13.—Cows grazing sericea in Kentucky in November. Two crops of hay had previously been taken from this field.

spring and keeping them there all summer. In western Kentucky in 1934 a farmer grazed his sericea with horses, mules, and dairy cows (fig. 13). In western Tennessee a farmer has grazed a 20-acre field for two seasons, and the cattle when sold in fall were as good as grass-fed cattle. This land is so poor that a grass pasture would yield almost nothing. Another Tennessee farmer, on good land, has grazed sericea for 3 years with cattle, hogs, and horses. He turns the stock on early. A farmer in Oklahoma reports having grazed his field with sheep and dairy cows from May 10 to frost. A Kentucky farmer kept 15 animal units on 8 acres of sericea from early spring until late June, when he took them off to cut a hay crop late in July. In the dry season of 1936 in north-central Tennessee, 40 cattle were kept on 4 acres for 6 weeks during which time they had no other feed.

Similar reports have come from other States. While more information is necessary before the place of sericea as a grazing plant can be definitely established, enough experience has been gained to warrant the statement that for land of low fertility few, if any, plants will furnish as good a cover and at the same time provide as much summer grazing as sericea. Studies indicate that grazing is most successful when the cattle are turned on when the sericea is about 4 to 6 inches high. At that stage of growth it appears to be palatable. Growth is so rapid, however, that care must be taken to graze heavily so that the sericea may not become too coarse. If growth is too rapid it should be clipped. Heavy early grazing and removal of stock to annual lespedeza pasture in late June appears to be a good plan. At this time the annual lespedeza will be in excellent shape for grazing, and the sericea may be allowed to produce a hay crop.

SEED PRODUCTION

Sericea is a heavy seeder. When sericea is planted in cultivated rows seed will be produced the first season. Yields of 500 to 1,000 pounds per acre have been reported from such plantings. A broadcast stand in its fifth year at Arlington Experiment Farm produced 1,600 pounds of unhulled seed per acre, but conditions were very favorable. Yields from established broadcast stands have ranged from 300 to 900 pounds per acre. Yields are smaller in a dry fall than when there is plenty of moisture.

Seed may be taken from the first or from the second growth. When the first growth is left for seed, yields are somewhat higher but the material is harder to cut and thresh than when the first growth is cut for hay and the second growth is allowed to seed. The yield of seed from the second growth will depend on the time the first growth is cut for hay. Usually the earlier the first growth is cut the larger the seed crop from the second growth.

The seeds are borne in clusters of two to four or more in a place. There are two kinds of flowers, those that show a corolla and are consequently conspicuous and those on which no corolla is developed. Both may occur in the same cluster. The flowers develop mainly along the branches but to some extent also along the main stem to within a few inches from the ground (fig. 14).

FIGURE 14.—A flowering branch of sericea.

HARVESTING

The seed pod of sericea turns brown at maturity and the crop should not be cut until most of the pods are brown. In the latitude of Washington, D. C., the crop matures about the end of October and should be cut as soon as possible thereafter. Cutting may be done with a mower having a windrowing attachment (fig. 8), with a binder (fig. 15), or with a combine. If the crop is cut with a sharp mower in early morning and laid to one side with a windrower there is very little loss of seed. It should be allowed to lie in the windrows until the leaves and the smaller stems, if present, have dried. The stems and main branches should be a little moist, as in this condition there will be less breakage in threshing.

FIGURE 15.—Harvesting sericea seed with a binder.

Threshing is best done with an overshot type of thresher having a concave with two rows of teeth above, rather than below, the cylinder. This makes for less breakage of the stems and it is these broken stems that stand up in the screen and cause choking. Feeding should be slow and the wind cut to the proper degree or much seed will be blown out with the straw.

Many growers using various types of threshers or combines have found it necessary to modify the screens or to remove some in order to prevent excessive choking. As a rule it is best not to attempt to clean the seed in the thresher but to pass it through a fanning mill. This makes for easier threshing and produces cleaner seed. Small combines may be used successfully, but the sericea should be riper than is necessary when it is cut with a mower. The secret of successful threshing appears to be slow feeding, controlled wind, and screens modified to avoid choking.

Hulling and scarifying can be done by a clover huller or by one of the commercial scarifiers now in general use. For scarifying small

quantities for home use, a barrel scarifier (*8*) (fig. 16), which may be made at home, or an old concrete mixer may be used. The container should have 1.5 pounds of gravel to 1 pound of seed. The stones should range from one-half to three-quarters of an inch in diameter. When the seed has been hulled in these machines it is also scarified.

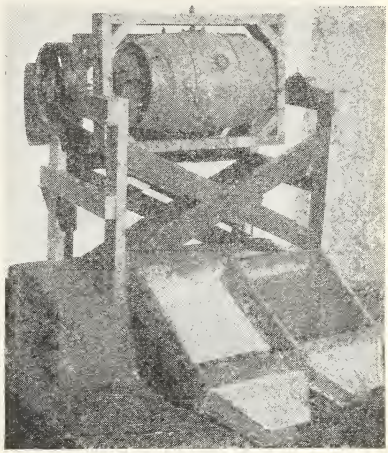

FIGURE 16.—A barrel scarifier.

APPEARANCE, WEIGHT, AND NUMBER OF SEEDS

The unhulled seed is brown, about one-eighth of an inch long, pointed, slightly reticulated, and hairy. The calyx of sericea very rarely remains with the pod; that of the annual lespedezas commonly does remain. The hulled seed is shaped like red clover seed but is smaller, greenish yellow, and somewhat mottled with brown (fig. 17). A measured bushel of clean sericea seed in the hull weighs about 34 pounds; hulled seed, 60 pounds. There are between 275,000 and 300,000 seeds in a pound of unhulled and 335,000 to 375,000 in a pound of scarified seed. A seeding rate of 20 pounds of scarified seed per acre will, if evenly distributed, place some 770 to 850 seeds on each square foot of surface. The loss in weight in hulling should not exceed 25 percent. Higher

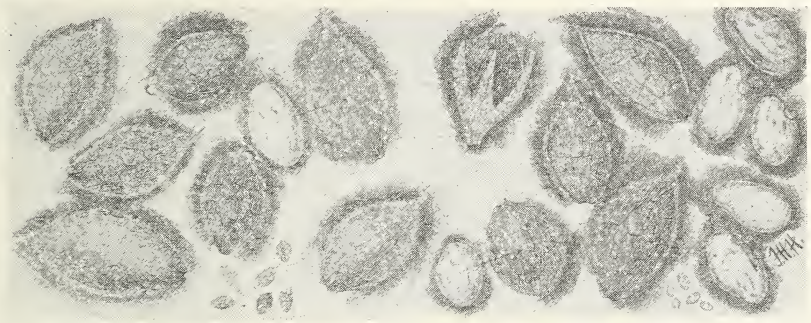

FIGURE 17.—Pods and seeds of *Lespedeza sericea*. (About 2 times natural size.)

losses up to 40 or more percent have been reported, but this was probably because the unhulled seed was not well cleaned.

SERICEA FOR WILDLIFE

All lespedeza seeds are relished by birds, and plantings of sericea have been proved to be well suited to this purpose. Not only are the seeds useful for food but the plants make an ideal cover for quail. The fact that the seeds are borne some distance from the ground and hang on until well into the winter is an additional advantage in sec-

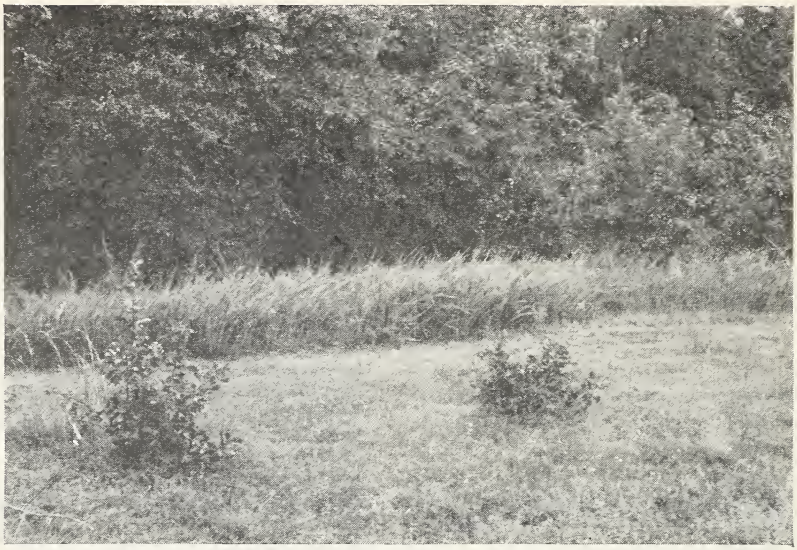

FIGURE 18.—Sericea for wildlife on the margin of a wood.

tions where snow may make it difficult for birds to get the seeds of low-growing plants. In a study of quail foods Stoddard (*20*) found that when quail had become accustomed to sericea seed they ate it freely and that it is a valuable late winter food. Further evidence of this use of sericea seed has been obtained in Virginia by the Bureau of Biological Survey.

Along margins of woods (fig. 18), on banks too steep for cultivation, in gullies, and in other places subject to erosion sericea may well be planted for no other purpose than to encourage wildlife by providing cover and food. Even in such places the first growth may often be cut for hay and the second allowed to produce seed without damaging in the least its part in erosion control and wildlife preservation.

SERICEA FOR SOIL IMPROVEMENT

Sericea is a deep-rooted legume and under suitable conditions the roots are well noduled. Unless cut excessively a considerable quantity of debris in the form of leaves will accumulate on the surface of the ground. It was shown on page 13 that the weight of roots may be as much as 2 or more tons of dry matter per acre. When a field that has been in sericea for several years is plowed, therefore, a considerable quantity of organic matter will be incorporated with the soil and this cannot fail to have a favorable effect on the growth of a subsequent crop.

Experimental data are at present available from one source only. At the West Tennessee Agricultural Experiment Station at Jackson (*13*) a stand of sericea that had produced hay or seed for 3 years was turned under and planted to corn. The corn crop produced 60.5 bushels per acre. While no check plot was provided it is of record that before sericea was grown on this land a crop of no more than 25

to 35 bushels would have been expected. The plot on which sericea was turned under produced as much corn that year as one receiving 10 tons of stable manure per acre. It was found that the sericea was plowed more easily than alfalfa and that there was no trouble in cultivating the corn. The residual effect was marked. Corn grown the second year after plowing under the sericea produced 55 bushels. Even in the fifth year of corn after sericea the effect of the sericea was still noted. While the dearth of experimental data makes it impossible to quote results, it may confidently be anticipated that eroded soils will be materially improved in productivity after having been in sericea for a term of years.

SERICEA FOR EROSION CONTROL

The vigorous growth and extensive root system of sericea even on eroded and worn land lead to the conclusion that it should be an excellent crop to aid in the control of erosion. This conclusion has been confirmed by experience. In the soil conservation campaign no other perennial legume has been found so widely useful for the region to which it is adapted.

At present experimental work on the effect of sericea on erosion control has not been developed, and information is limited to the observations made by Soil Conservation technicians, experiment-station workers, and farmers. All such information leads to the conclusion that sericea is extremely useful in the control of erosion. During the growing season the crop provides a canopy through which even the heaviest rains cannot reach the soil surface directly and in winter the living crowns and roots bind the soil. The stubble from a harvested crop also serves as an obstruction to the flow of water. When sericea is planted for wildlife, in gullies, or on isolated places that need protection, the accumulation of leaves and stems soon forms a dense cover that protects the soil from beating rains and slows run-off.

In Caldwell County, N. C., a 50-acre eroded field was seeded to sericea in 1933 and by 1937 the small gullies had healed and erosion had been completely controlled (fig. 19). In Weakley County, Tenn., a 12-acre gullied field was so smoothed in 2 years that erosion was completely controlled. In Kentucky a badly eroded field was seeded to sericea without any attempt to smooth small gullies; yet in 3 years these were being perceptively filled and erosion was no longer a problem. On various soil conservation projects sericea has controlled erosion on critical slopes, banks, and eroded fields and in gullies.

PLACE OF SERICEA IN THE SOIL CONSERVATION PROGRAM

In the soil conservation program plants are needed that will control erosion, improve the soil, and at the same time return some revenue. In the area to which sericea is especially adapted the soils on which erosion is to be controlled are in the main soils of low productivity, and large revenues are not to be expected if the soil is to be protected and improved.

Throughout the region to which it is adapted sericea may be used on all areas that because of slope, erodibility of soil, or unproductiveness should be retired from cultivation for long periods or permanently. It is but natural that the farmer should want to derive some revenue,

FIGURE 19.—This severely eroded hill, shown in part in (*A*), was later covered with sericea (*B*). Erosion is controlled and the gullies are healed.

and this can be provided by sericea if proper attention is paid to getting the stand and to subsequent care and utilization. Sericea is not suited to short rotations. For such rotations crops as annual lespedeza or mixed clover and grass meadows should be used. Where fields that have been reduced to a low state of productivity are so situated as to make cultivation an erosion danger, sericea can well be seeded. Lime and phosphate should be applied, and every care should be taken to establish a good stand. After a stand is secured, from 1 to 2 tons of good hay may be taken annually with no further expense than harvesting. Care must be taken not to cut too often if it is desired to maintain a vigorous growth for a long term of years. With proper attention a good cover may be maintained for 7 to 10 years and perhaps longer.

One marked advantage of sericea as a hay plant is that the crop can be harvested earlier than any other crop suited to poor soils. A farmer finding himself out of other feed in spring has but to cut his sericea, which is ready early. It is also an excellent emergency crop in an extremely dry season, when it may produce the only feed available.

Sericea may be useful on steep banks and critical slopes and in stabilizing terraces (fig. 20). It is sometimes planted above a terrace channel so as to sift out the soil carried from a higher cultivated strip. This tends to keep the channel from silting.

Sericea is being successfully used in meadow outlets (fig. 21). It is best to divert the water from these outlets during the seeding year, but when the cover is established it may be expected to last for many years and to carry whatever water passes through the outlet without danger of cutting. Sericea may be used where a permanent strip is desired in a cultivated field. Such a strip should be wide enough to cut for hay. Narrow buffer strips of sericea may also be used in critical places even if such a strip cannot be made wide enough to be cut conveniently (fig. 22). It will serve as a wildlife shelter and will not be a menace to the farm as would a similar strip left to grow up to weeds.

Sericea is useful for stabilizing large gullies (fig. 23). Planted on the ridges and slopes of the gullies with the seeding temporarily protected by mulch it may be expected to cover the eroded areas and prevent further growth of the gully. At the same time such an area makes an ideal wildlife resort. Plants of sericea have been set by hand on gully or road banks where seeding was difficult. Before long these plants serve to control washing and stabilize the bank. In southern Virginia many acres of hillside and gully have been planted to sericea from which the owner is said to have derived a good income for the shooting rights.

SPECIES AND VARIETIES OF PERENNIAL LESPEDEZAS

VARIETIES OF LESPEDEZA SERICEA

Lespedeza sericea is variable, the variations observed being in shape of leaflets and earliness of maturity. Two varieties or strains have been introduced, Nos. 12087 and 04730. Under the same conditions No. 04730 grows a few inches taller than No. 12087, matures seed a week or two earlier, and appears to be somewhat more winterhardy. At the West Tennessee Agricultural Experiment Station

FIGURE 20.—Sericea stabilizes terraces in Alabama.

FIGURE 21.—Sericea is useful in a meadow outlet.

FIGURE 22.—Sericea as a buffer strip on a critical area in a cultivated field, Tallapoosa County, Ala.

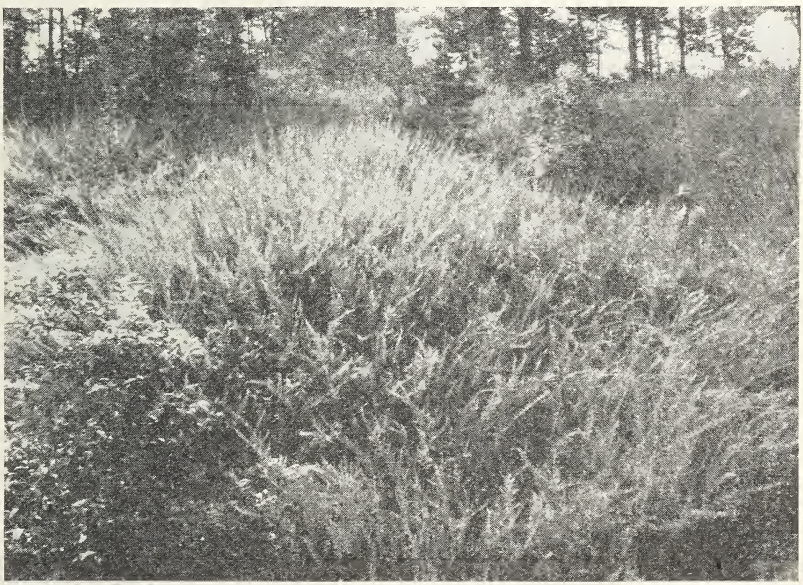

FIGURE 23.—Sericea will cover and stabilize a gully.

FIGURE 24.—Nursery of perennial lespedezas at Arlington Experiment Farm, Va.

it has been shown that the advantage in earliness and vigor of growth of No. 04730 is great enough to permit one more cutting of hay per season than of No. 12087. A selection of a single plant from No. 04730 proved to be somewhat more uniform in growth than the original field of it but did not differ in other respects. Other varieties have been tested at the Bureau of Plant Industry nurseries and some mature much earlier than No. 04730. They have not, however, appeared to possess other advantages warranting introduction. Individual variations appear to exist in the tannin content, and this variation is being made the basis of selection for a more palatable strain.

NATIVE AMERICAN SPECIES

The native American species are all herbaceous perennials. Two species (*Lespedeza repens* and *L. procumbens*) are prostrate in habit, the others more or less erect. The most common species have been described (*18*). Of these *L. virginica* most nearly resembles *L. sericea* in habit and leaf form and has often been mistaken for the latter. *L. frutescens* is said to have been eaten by cattle. These species all contain tannin, but no analyses have been made of material at different stages of growth. Information on the effect of age on tannin content is, therefore, not available.

The American species never occur in dense stands but affect dry, gravelly banks, margins of woods, and other well-drained areas. These species are all subject to a rust (*Uromyces lespedezae-procumbentis*) that may be severe enough to cause defoliation. The oriental species grown in the United States are fortunately free from this rust. In Japan a rust described under the above name has been reported from several species (*6*). Teliospores of this form have been found on pods and leaf debris imported with seed from the Orient and

FIGURE 25.—*Lespedeza bicolor* holding a bank.

Mains [10] has shown that such teliospores may germinate. There appear to be two physiological races of this rust, one confined to the American species and the other to the oriental forms. Since it is possible for teliospores of the oriental form to germinate, the greatest care should be taken in importing seed from the Orient lest this form become established on the oriental species introduced into the United States.

OTHER PERENNIAL SPECIES

A few of the other herbaceous perennials have been grown in the Arlington Experiment Farm nurseries and elsewhere (fig. 24). Of these a species tentatively identified as *Lespedeza juncea* appears to offer promise as an erosion-control plant. From preliminary trials it seems that the seeds germinate somewhat more quickly and that the seedlings make a somewhat more rapid growth than those of sericea. This conclusion is based on a number of observations, but no exact measurements are available. *L. juncea* resembles *L. sericea* but is somewhat more bushy and less leafy and does not grow as tall and erect as *L. sericea*. The stems are reddish, and the leaflets are long and oval, not truncate as in *L. sericea* (*17*). From the few determinations so far made it is believed to have about the same tannin content as *L. sericea*. Its value for forage has not been determined.

Lespedeza latissima has a prostrate or semiprostrate habit. In one strain, No. 19283, the branches lie flat on the ground. Another strain, No. 19285, produces numerous stems that are at first erect but soon bend down so that the plant forms a low bush about 1 foot high. Other species belonging to the sericea group are *L. inschanica*, having larger leaflets and coarser growth, and *L. cystoides*, having long narrow, pointed leaflets. These have been described (*17*) but have not been tested for erosion control or forage value.

[10] E. B. Mains. Letter to author, May 12, 1930.

FIGURE 26.—In Chosen baskets are made from the branches of *Lespedeza bicolor*.

Lespedeza daurica appears in two forms, one erect the other prostrate. Both have coarse stems, relatively few in number, and coarse leaves. Seed production is abundant, and the species may have value as food for wildlife. *L. tomentosa* is a coarse, erect plant with large tough leaves. With the possible exception of the use of the seeds by game birds these two species do not appear to be of economic importance.

Of the oriental shrubby species *Lespedeza bicolor*, *L. japonica*, and *L. thunbergii* have long been known in North America as ornamental plants, sometimes under other names (*1*). Other ornamental species have been reported as being cultivated in Europe, as *L. delavayi*, which has deep-violet or purplish-black flowers (*4*). *L. bicolor* is also being used in the Soil Conservation Service along stream banks for wildlife food. It may prove useful for stabilizing the sides of gullies and banks (fig. 25). *L. bicolor* has been grown in Japan experimentally for hay production. Yields and quality are said to have been good (*10*). This species is also reported as having been used in Chosen and Japan for erosion control on steep slopes. In Chosen stress is laid on the need for inoculation. It is advisable to mix the seed with soil known to be well inoculated and to sow in shallow furrows on the contour. Under such treatment it is said to do well on sterile, badly eroded areas. The stems of *L. bicolor* are used in Chosen for basket making (fig. 26).

A closely related species, *Lespedeza cyrtobotrya*, has been grown in the Arlington Experiment Farm nurseries and at various points in the South. While the leaves of *L. bicolor* and *L. cyrtobotrya* are much alike, the flowering panicles of *bicolor* are expanded while those of *cyrtobotrya* are borne in dense axillary clusters. Both species contain

tannin in about the same percentages as that found in sericea at a comparable stage of maturity. Only a few determinations have been made, however, and no statement of average tannin content can be made.

In the latitude of Washington the current growth of these and of other shrubby species is often killed nearly to the ground. In that case new growth comes from the crowns as well as from the stubs that

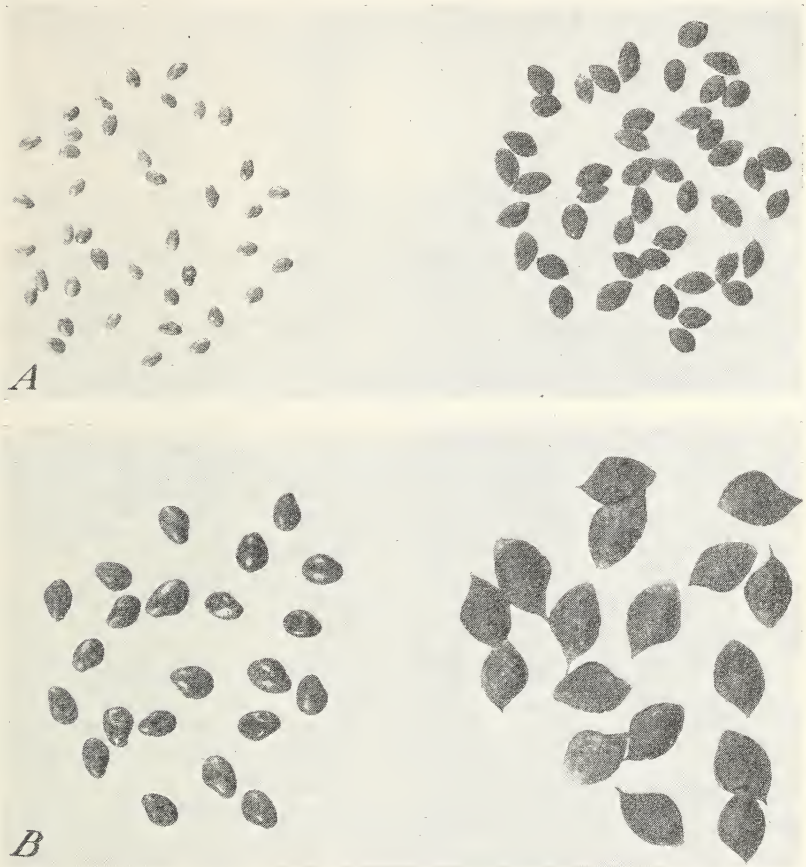

FIGURE 27.—Seeds of *Lespedeza sericea* (*A*) are smaller than those of *L. bicolor* (*B*). (About 1½ times natural size.)

escape the cold. In Georgia the current growth is not killed back far and the plants become woody shrubs with several stems from the crown, each stem an inch or more in diameter.

The pods and seeds of the shrubby species are much larger than those of the herbaceous species (fig. 27). From the few observations made, they appear to be preferred by quail to those of *Lespedeza sericea*. The loss in hulling of *L. bicolor* was found to be 30 to 35 percent. A pound of unhulled seed contains 50,000 to 60,000 seeds.

CHROMOSOME NUMBERS IN LESPEDEZAS

Chromosome numbers have been determined for a few species and it is apparent that some variations occur. As reported by Cooper (*2*) the chromosome number of *Lespedeza sericea* and of *L. variegata* [*L. inschanica*] is 18, of *L. stipulacea* and of *L. tomentosa*, 20, and of *L. daurica*, 36. Kawakami (*9*) has reported 9 as the haploid chromosome number of *L. bicolor*, *L. cyrtobotrya*, *L. homoloba*, *L. sieboldii*, and *L. sieboldii*, *var. albiflora*. The haploid number should be multiplied by two to correspond to those reported by Cooper.

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